



## Technology Focus: Test & Measurement

### Method to Estimate the Dissolved Air Content in Hydraulic Fluid

**A dissolved oxygen meter is used.**

*John H. Glenn Research Center, Cleveland, Ohio*

In order to verify the air content in hydraulic fluid, an instrument was needed to measure the dissolved air content before the fluid was loaded into the system. The instrument also needed to measure the dissolved air content *in situ* and in real time during the de-aeration process. The current methods used to measure the dissolved air content require the fluid to be drawn from the hydraulic system, and additional offline laboratory processing time is involved. During laboratory processing, there is a potential for contamination to occur, especially when sub-saturated fluid is to be analyzed.

A new method measures the amount of dissolved air in hydraulic fluid through the use of a dissolved oxygen meter. The device measures the dissolved air content through an *in situ*,

real-time process that requires no additional offline laboratory processing time. The method utilizes an instrument that measures the partial pressure of oxygen in the hydraulic fluid. By using a standardized calculation procedure that relates the oxygen partial pressure to the volume of dissolved air in solution, the dissolved air content is estimated.

The technique employs luminescent quenching technology to determine the partial pressure of oxygen in the hydraulic fluid. An estimated Henry's law coefficient for oxygen and nitrogen in hydraulic fluid is calculated using a standard method to estimate the solubility of gases in lubricants. The amount of dissolved oxygen in the hydraulic fluid is estimated using the Henry's solubility coefficient and the measured partial

pressure of oxygen in solution. The amount of dissolved nitrogen that is in solution is estimated by assuming that the ratio of dissolved nitrogen to dissolved oxygen is equal to the ratio of the gas solubility of nitrogen to oxygen at atmospheric pressure and temperature. The technique was performed at atmospheric pressure and room temperature. The technique could be theoretically carried out at higher pressures and elevated temperatures.

*This work was done by Daniel M. Hauser of Glenn Research Center. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18621-1.*

### Method for Measuring Collimator-Pointing Sensitivity to Temperature Changes

**A simple, inexpensive, low-tech method is proposed for testing pointing stability versus temperature and other environmental influences.**

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For a variety of applications, it is important to measure the sensitivity of the pointing of a beam emerging from a collimator, as a function of temperature changes. A straightforward method for carrying out this measurement is based on using interferometry for monitoring the changes in beam pointing, which presents its own problems. The added temperature dependence and complexity issues relating to using an interferometer are addressed by not using an interferometer in the first place. Instead, the collimator is made part of an arrangement that uses a minimum number of low-cost, off-the-shelf materials and by using a quad diode to measure changes in beam pointing.

In order to minimize the influence of the test arrangement on the outcome of

the measurement, several steps are taken. The collimator assembly is placed on top of a vertical, 1-m-long, fused silica tube. The quad diode is bonded to a fused silica bar, which, in turn, is bonded to the lower end of the fused silica tube. The lower end of the tube rests on a self-aligning support piece, while the upper end of the tube is kept against two rounded setscrew tips, using a soft rubber string. This ensures that very little stress is applied to the tube as the support structure changes dimensions due to thermal expansion. Light is delivered to the collimator through a bare fiber in order to minimize variable bending torque caused by a randomly relaxing, rigid fiber jacket.

In order to separate the effect of temperature on the collimator assembly

from the effect temperature has on the rest of the setup, multiple measurements are taken with the collimator assembly rotated from measurement to measurement. Laboratory testing, with 1-m spacing between the collimator and the quad diode, has shown that the sensitivity of the arrangement is better than 100 nm rms, over time spans of at least one hour, if the beam path is protected from atmospheric turbulence by a tube. The equivalent sensitivity to detecting changes in pointing angle is 100 nanoradians.

*This work was done by Alex Abramovici, Timothy E. Cox, Randall C. Hein, and Daniel R. MacDonald of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47529*